Geological/Geophysical Studies in East Asian Marginal Seas

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LONG-TERM OBJECTIVES

The long-term objective of this project is to understand more completely the shallow marine geology and surface oceanography of the east Asian seas, particularly in light of the large sediment fluxes from present-day rivers and late Quaternary fluctuations of sea level.

SCIENTIFIC OR TECHNICAL OBJECTIVES

This study entails the analysis of existing data combined with acquisition of new geological and geophysical data; collectively they will facilitate better geological and geoacoustical models of east Asian marginal seas.

BACKGROUND

The East China Sea and Yellow Sea (ECS/YS) represent one the world's largest existent epicontinental shelves, with a width greater than 600 km and water depths generally less than 100 m. Onto this broad shelf discharge two of the world's largest rivers – the Yangtze and Yellow. Combined historic sediment loads of these two rivers have been measured to exceed 1.5 billion tons annually, equal to a volume of approximately 1 km^3. However, sediment flux to the ECS/YS has varied greatly since the last glacial maximum (LGM), in response to rising sea level (beginning about 22ka), climate change – particularly the re-initiation of the southwest monsoon (about 10-11 ka) - and the impact of deforestation and agricultural practices beginning about 3 ka. Complicating our ability to understand this area has been the uneven distribution and quality of oceanographic and geological/geophysical data that are necessary to achieve a comprehensive picture.

It is against this background that we have been working, with particular emphasis in the North Yellow Sea, a critical area in linking the Gulf of Bohai (present sink for Yellow River-derived sediment) and the South Yellow Sea. Research carried out in cooperation with the Chinese Academy of Science's Institute of Oceanology, in Qingdao, resulted in two geological and geophysical cruises in 1998 and 1999 to the North Yellow Sea, combined with an extensive data search and compilation of previous work in the entire Gulf of Boahi and Yellow Sea (both North and South). This work has formed the basis for a PhD dissertation by Jing-pu (Paul) Liu, at the School of Marine Science, College of William and Mary.

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14. ABSTRACT
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15. SUBJECT TERMS

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ACCOMPLISHMENTS AND RESULTS

Through this program, we have acquired more than 1000 km of high-resolution (boomer) seismic data plus 60 grab samples and 10 box cores from the North Yellow Sea. All these data, plus all the data gathered from the extensive Chinese literature, have been archived in a GIS (ArcView) database, which on several occasions have been shared with NAVOCEANO personnel. (Parenthetically, while not a specific goal of this project, we also have shared with NAVOCEANO the results of our extensive global river-database, which presently includes data on more than 1500 rivers that discharge into the global ocean – by far the world's largest such database.)

We have defined a thick lens of Yellow River-derived sediment that wedges out against the northern shore of the Shandong Peninsula. This clinoform wedge appears to have formed during the early Holocene transgression of sea level. An even more interesting possibility is that a significant portion of the sediment in the Shandong Mud Wedge may come from local erosion of the coastline and from coastal rivers.

To gain a better insight into the origin(s) and history of this mud wedge, we examined the post-LGM sea-level history in the ECS/YS, and compared this with the commonly accepted sea-level curve derived from coral-reef cores at Barbados, New Guinea and Tahiti. Through this research we have found two interesting things: 1) the coral-reef-derived sea-level curve is probably as accurate as previously thought; and 2) post-LGM sea level appears to have risen in a step-wise fashion rather than in the uniform way envisioned in most conceptual models. To quote directly from the abstract of a paper recently submitted to *Science*:

> Coral reefs generally cannot accrete vertically faster than 10-15 mm/yr, thereby causing reef-based sea-level curves to under-estimate rapid flooding events and over-estimate intervening slow rates of transgression. Integrating coral-reef dates with other published dates, primarily from the East China and Yellow seas, shows a step-like post-glacial transgression of sea level marked by five short periods of rapid rise (11-45 mm/yr), at least some of which correspond with periods of rapid climatic change.

We also have been working with Dr. Bong-Chool Suk, from the Korean Ocean Research and Development Institute (KORDI), on the distribution and thickness of post-LGM sediments off southwestern South Korea. Analysis of high-resolution seismic data (gathered both during a VIMS/KORDI cooperative cruise in 1999 and before and since by KORDI) has allowed us to delineate sediment depocenters, most of which apparently were deposited during the post-LGM transgression and subsequently reworked by the modern oceanographic regime, particularly tides. These data will be incorporated within a geological atlas of the entire Yellow Sea that we are in the process of preparing together with help from Chinese, Korean and Japanese colleagues.

IMPACT ON SCIENCE

The most significant impact of the Yellow-Sea research probably will not be the study of the North Yellow Sea or understanding how its morphology, shallow marine geology, and recent history relate to other areas within the East China Sea and Yellow Sea, but rather the recognition that post-LGM sea-level rise has been step-wise: very rapid flooding events with intervening slow rises, periodically perhaps even minor and temporary regressions. Again, to quote directly from our *Science* paper:

Recognizing a stepwise transgression in post-LGM sea level allows marine geologists an opportunity to view the deposition of shelf and inner shelf deposits in a new light. Rapid sea-level rise during melt-water pulses back-stepped the shoreline, thereby increasing the accommodation space to be filled during the subsequent slow transgression. Combined with climatic change (e.g., increased SW monsoon about 11 ka BP), post-LGM continental margin sedimentation history may have been more episodic than previously believed.

Recognizing this step-wise transgression may lead to a (minor) paradigm shift. It will force us to reanalyze and reconsider our interpretation of the nature and origin of Holocene shelf sediments, particularly shelf clinoforms.

SUBMITTED PAPERS

- Liu, P., Milliman, J.D. and Gao, S. The Shandong Mud Wedge and Holocene Sediment Accumulation in the Yellow Sea. *Geomarine Letters*. in Press

- Liu, P. and Milliman, J.D. Post-Glacial Sea-Level Transgression in the East China and Yellow Seas: Significance of Periodic Rapid Flooding Events. Submitted to *Science*, Sept. 2001.

- Milliman, J.D., 2001. Delivery and Fate of Fluvial Water and Sediment to the Sea: A Marine Geologist's View of European Rivers. *Scientia Marina*, 65 (suppl. 2), 121-132.

Invited Talks

- Global Rivers and the Yellow Sea. Naval Oceanographic Office, Stennis Space Center, MS. May 2001

- River Delivery and Fate in the Global Coastal Ocean. Tulane University, May 2001

- River Delivery and Fate in the Global Coastal Ocean. New Zealand National Institute for Water Analysis. Wellington, NZ, July 2001

- Global Rivers: Present and Future Problems in Southern Asia. SCOPE biennial meeting, Bremen, Germany, Sept. 2001